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DEPARTMENT OF COMMERCE

TECHNICAL NEWS BULLETIN
OF THE BUREAU OF STANDARDS

Subscription, 25 cents a year. Address "Superintendent of Documents, Government Printing Office, Washington, D. C."

Washington, February 1926—No. 106

TEMPERATURE CHANGES EFFECTIVENESS OF BRAKE LINING

Laboratory tests at the bureau of the asbestos textile brake lining materials, which are almost universally used in automotive vehicles, show that there is a pronounced decrease in coefficient of friction when the linings are operated under test conditions which cause a rapid increase of temperature of several hundred degrees.

Recently these tests have been paralleled by a series of experiments with the brakes on a conventional design of passenger car in actual service. Particular attention was devoted to a study of changes in braking ability with changes in temperature. The test equipment made it possible to obtain measurements of the temperatures of the brake linings, the pressure applied at the foot pedal, and the braking ability.

In general, all of the tests made with conventional linings showed the same general characteristic that had been observed in the laboratory tests; namely, a reduction in coefficient of friction with large increases in lining temperature. One special lining containing no saturant, but being in other respects similar to the other linings, showed no appreciable change in coefficient of friction with change in temperature. That a saturant is needed is indicated by the fact that this particular lining in this brief series of tests became blackened and the cotton content became charred at the surface and considerably frayed. Nevertheless, the marked difference between the behavior of this lining and the saturated linings indicates that it is the action of the saturant which is almost entirely responsible for decreases in coefficient of friction with increase in temperature.

The tests indicate that it is far more important to develop brake linings with coefficients of friction which vary over only a comparatively narrow range than to develop linings which under ideal conditions have extremely high coefficients. Moreover, the tests emphasize the importance of designing the brake mechanism so that satisfactory braking ability will be available when conditions are such that the coefficient of friction of the lining becomes abnormally low.

AUTOMOBILE HEADLIGHTING

For several years the bureau has been working with technical societies, State officials, and others in the attempt to improve the headlighting of automobiles. This question has been revived more actively than ever during the past year as the result of discussions following the National Conference on Street and Highway Safety called by Secretary Hoover in December, 1924. In order to obtain more complete and reliable information regarding the actual status of headlighting and the possibility of its improvement, a joint committee representing the Society of Automotive Engineers and the Illuminating Engineering Society has recently been formed and is attempting to lay out a program of research on this subject. Members of the bureau's staff have been appointed as representatives of both so-

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cieties on this committee. The bureau has also been called on for technical advice in connection with the requirements of the proposed uniform vehicle code which is to be considered at the next meeting of the national conference. In this connection the bureau has advocated the general plan of making laws and regulations as simple as possible and depending upon education of motor-car manufacturers and users for the betterment of actual road conditions. With this in view, Circular No. 276, Motor Vehicle Lighting, was issued some time ago and has found extensive circulation. This circular is not available for free distribution, but can be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., for 20 cents per copy.

COMPARATIVE QUALITIES OF AMERICAN AND GERMAN FIRE-CLAY BRICK

In a cooperative investigation by Doctors Endell and Steger, of the Technische Hochschule of Berlin, Germany, and the Bureau of Standards, the characteristics of fire brick manufactured in this country and in central Europe are being compared.

Manufacturers of fire brick in the Kentucky, Pennsylvania, and New Jersey districts have shipped samples of their product to Doctor Endell and to this bureau, and Doctor Endell has submitted five different brands of German-made brick representing the manufacturing districts of eastern and western Germany. Among these brands of brick three types of fire-clay refractories are represented (silicious, semisilicious, and the aluminous) and also four methods of manufacture (handmade, repress, stiff-mud, and dry press).

The complete results of tests by Endell and Steger have not as yet been received, but the laboratory work, which was to be carried out by this bureau on the foreign brick, has been completed, and the data collected compare favorably with those furnished by the German laboratories.

The results may be summarized as follows: The German-made brick average 1 pound heavier than the American-made brick and are correspondingly larger in size; the silica content of the German brick averages slightly higher and the titania slightly lower.

The average deformation of the German brick under load at high temperatures is 2.6 per cent greater than the American; the German brick are 25 per cent less resistant to spalling; and the refractoriness of the American and German brick, expressed in terms of pyrometric cones, is approximately the same. In general, the data obtained at this bureau indicate that the American-made brick are equal to, if not slightly superior to, the German product.

SOME PHYSICAL PROPERTIES OF SAND-LIME BRICK

An investigation to determine the strength of the bond between mortar and sand-lime brick is now being conducted by the bureau. One phase of the problem necessarily consists of a study of the effect of various physical properties of the brick, such as total absorption, rate of absorption, density (including pores), specific gravity of solids in the brick, and rate of drying, upon the adhesion of the mortar to the brick. Consequently these properties have been determined upon 1,325 individual bricks, representing the product of eight manufacturers. Some very interesting relationships have been found to exist, including the following:

When sand-lime brick are immersed in water, those of the highest total absorption show the most rapid rate of absorbing water at the start, and they are the first to approach a condition of saturation; the limit of their capacity for absorbing water is nearly reached in 12 hours, and very little more water is absorbed if the immersion is continued for seven days. At the end of seven days' immersion sand-lime bricks contain on the average 4 per cent less water than when boiled for five hours. The rates of absorbing water sometimes vary more between bricks of one make than

between the average rates of bricks of two makes.

The specific gravity of the solids in sand-lime bricks is so nearly the same that one can locate a smooth curve by plotting the points which represent the total absorption and the density (including pores) of a number of bricks. Such a curve can be used in determining the total absorption of other sand-lime bricks without the use of water merely by determining the density of each.

Bricks which are more porous dry out a little faster than those less porous and retain less water when air dry, which amount varies from 0.5 to 1.0 per cent or more of water, depending upon the material of the brick and the relative humidity.

CLEANING PREPARATIONS FOR INTERIOR MARBLE

A study of cleaning preparations for interior marblework has been initiated at the bureau to determine if present cleaning methods and preparations are in any way detrimental to the highly prized color tones and ornamental features of marble. The cleaning materials in use for this purpose were developed with reference to their detergent value and with no particular thought of the injurious effects which they might produce on the costly objects being cleaned. It is only recently that serious consideration has been given to determining if different cleaners are injurious to marble.

One means adopted by the bureau for determining the action of various cleaning preparations is a long-period scrubbing test which submits samples of marble to as much scrubbing as the marble would receive in 50 years of normal use. This test brings out certain points of interest which clearly indicate that some of the present cleaners, now widely used, are not well adapted for cleaning polished ornamental marblework.

The experimental work along this line does not stop after proving that certain cleaners are injurious. Its main object is eventually to develop a preparation of satisfactory detergent value that will be safe in the hands of charwomen. Since marble holds the highest rank among decorative building materials and is relatively low in cost, it is found in practically every type of building. Hence, any improvement that can be made in cleaning materials or methods, it is believed, will have a widespread value.

PROBLEMS RELATING TO SAGGERS

An outline of proposed future work in connection with the investigation which the bureau is conducting on saggers appeared in a paper entitled "Progress report on investigation of sagger clays," published in the February issue of the Journal of the American Ceramic Society. In accordance with this program, work on the determination of the thermal expansion of all sagger clays from room temperature to 1,000° C. has been started and considerable progress made.

Twenty-five specimens of sagger clays have been tested for thermal expansion from room temperature to 1,000° C. In analyzing and correlating the results with data obtained in other physical tests conducted on these clays some striking features were brought out: (a) As the expansion (from 20° C. to temperature - of - failure - in - quenching test) increased from 0.25 to 0.45 per cent, the average moduli of rupture of these clays decreased from over 3,000 pounds per square inch to less than 2,000 pounds per square inch, and the average porosity increased from 22 to 28 per cent; (b) the average expansion which took place from room temperature to 300° C. increased as the "expansion interval"—that is, the expansion between 20° and the temperature of failure in the quenching test—increased; (c) classifying the clays into two groups according to expansion behavior and to the temperature required to produce failure in thermal shock tests shows one group to have an average expansion of 0.15 per cent from 20 to 300° C., with failure of the clay saggers when quenching from an average temperature of 588° C., and the

other group to have an expansion of 0.231 per cent and failing at an average temperature of 424° C.; and (d) the expansion behavior of the clays was of two distinct types. In one type there is a noticeably high rate of expansion from 100 to 200° C., whereas in the second type this high rate does not obtain.

BUCKLE STRENGTH OF LEATHER

Leather straps are often used under heavy load (in harnesses and safety belts) with buckles and fastening devices. Aside from the fact that the tensile strength of the particular strap in question is lowered because of the punching of holes for the buckle tongue, tests at the bureau have also shown that the stress required to pull the leather through the buckle varies with the location on the hide. Strips of harness leather from different hide locations were cut 6 inches long and 1 inch wide. A hole was punched in the center of each strip an inch from one end, and the punched end was inserted in an ordinary 1¼-inch harness buckle which had a tongue about 0.2 inch in diameter. The other end of the strip was inserted in one jaw of the testing machine. The buckle was attached to a strap and secured in the other jaw of the machine, and the number of pounds required to pull the test piece through the buckle was noted.

The results obtained varied from 50 to 350 pounds. Within an area of 15 inches either side of the backbone and 30 inches from the root of the tail the buckle strength always exceeded 200 pounds. The results show that the belly and shoulder portions are inferior to the remaining portion of a hide for use in straps which are to be used with buckles, and in cutting leather for straps to be used under heavy-duty conditions it appears advisable to have the punched end cut from the location above described.

CROSS STREAKS IN RAYON TUBING

Rayon knitted fabrics occasionally come from the dye bath with regular changes in shade running across the width. This condition had been brought to the attention of the bureau for study at several different times, but the necessary information regarding the stages of manufacture was lacking.

Recently, however, this result occurred in a mill while manufacturing tubings of five different colors. Analysis showed that the same kind of rayon was used in each case. The size, number of filaments, tightness of stitch, and twist of the rayon yarn were found to be even.

The tubing was made on a six-feed machine. By unraveling the fabric sufficient yarn was obtained to knit separate fabrics from each of the feeds on a single-feed machine. The resulting fabrics showed a distinct variation in the shade. Since the material was dyed in the same bath, it was indicated that the variation was caused by different absorption qualities of the rayon fiber. This indication was confirmed by "stripping" the original samples. In this operation it was found that the darker portions required longer to strip than the light portions.

This study, indicating as it does the variation occurring in different lots of rayon made in the same plant by the same process, shows that a manufacturer using rayon for knitting or weaving must be careful not to mix shipments if the material is to be piece dyed later. The real reason why the rayon reacts in this manner has not been discovered. One theory has been advanced—that the aging of the rayon affects its properties.

OPACITY OF THIN BOOK PAPERS

The paper section of the bureau has recently completed opacity tests of a number of thin, light-weight book papers, commonly known as India or Bible papers, the object of these tests being to assist in the selection of paper for a scientific publication. Such paper has long been employed for Bibles, encyclopedias, and other similar publications, its use serving to reduce materially the bulk and weight of the publications, making them more convenient to handle and conserving filing space. These considerations, as well as the pleasing ap-

pearance of this type of paper, are rapidly extending its use to many other kinds of publications, especially those in the technical and scientific fields.

Owing to the thinness of such paper, the degree of opacity is an essential consideration, as the printing may show through to the opposite side to an extent sufficient to give the printed pages an undesirable appearance or even to make them difficult to read. The required opacity is usually obtained by using a large proportion of mineral filler. Precipitated calcium carbonate is sometimes used instead of the ordinary china clay filler, as the former is thought to lend greater opacity. Special fibers are also sometimes employed, notably those from straw, as there is some difference in the opacity of different kinds of fibers.

The papers tested range from 25 to 40 pounds in weight. Above 40 pounds or so the paper is thick enough to give little difficulty because of lack of opacity. The opacity was determined by means of a Martens photometer, using the method and apparatus described in Bureau of Standards Circular No. 63. The following values were obtained, these being expressed in terms of contrast ratio as described in the circular. The weights given are on the trade custom book paper basis of 500 sheets, 25 by 38 inches in size.

Opacity of thin book papers

25-pound	30-pound	35-pound	40-pound
0.866	0.889	0.840	0.901
.868	.901	.933	.891
.873	.898	.933	----------
.885	.904	----------	----------
----------	.916	----------	----------
----------	.857	----------	----------

An examination of printed sheets of the various papers showed that the extent to which the printing showed through was in good agreement with the opacity values found. This confirmed the results of other such comparisons made, all of them indicating that the opacity test is of considerable service in the selection of such papers. This test can not be advocated as a final criterion, however, as the extent to which the ink penetrates the paper also influences the showing-through factor. As there is no adequate laboratory test available for measuring this property of the paper, it is advisable, after making certain that the paper has satisfactory opacity, to subject it to a trial printing as a final test.

The experience gained in comparing opacity tests with actual printing tests indicates that a minimum opacity of around 0.89 contrast ratio is required for a satisfactory printing job. A variation of approximately 0.01 contrast ratio has been found readily perceptible to the eye.

VISIT OF GLUE ASSOCIATION MEMBERS TO THE BUREAU OF STANDARDS

The members of the National Association of Glue Manufacturers, attending their quarterly association meeting at Washington, visited the paper section of the bureau on the afternoon of January 26. An inspection was made of the bureau's experimental paper mill, during which the equipment was seen in operation as a part of the investigation of the use of glue in engine sizing. Dr. George K. Burgess, director, welcomed the visitors to the bureau.

A meeting was then held, at which George K. Hamill, research associate of this association, delivered his report on the progress of the cooperative research in the paper section. This report summarized briefly the results obtained to date, explained the problems now under investigation, indicated certain questions that should be studied, and suggested ways in which this research may be applied by the glue manufacturers. The major problem under investigation has been the use of glue in coated paper. In addition, considerable work has been done on surface or tub sizing. At present the major investigation is that of the use of glue in the paper beater, or engine sizing. Preliminary work on this problem carried out several months ago on wood-fiber papers indicated that by using glue in the beater their strength was increased; that the effectiveness of rosin sizing was increased,

and that in making book papers better retention of clay fillers was secured. Through the present work it is believed that conclusive data on these points will be obtained.

PREVENTION OF DISTORTION IN LENSES USED FOR COPYING AND ENLARGING

At the request of a manufacturer the bureau investigated a method for neutralizing the distortion of a photographic lens when used for copying at an enlargement of two times. All the lenses with which the bureau is familiar have distortion under these conditions greatly exceeding the tolerances permitted in the use of this lens. Measurements of distortion, when made with a plane parallel plate of suitable thickness against the lens on the object side, show that the distortion may be thereby reduced to 15 per cent of its original value at 30° from the axis. By using plates of various thicknesses the distortion may be made small for any particular region of the field of view of the lens.

PIEZO-ELECTRIC QUARTZ PLATE FOR MAINTAINING CONSTANT FREQUENCIES FROM RADIO STATIONS

Recognizing the basic importance of maintaining broadcast station frequencies constant, the Fourth National Radio Conference recommended "that the Department of Commerce require all stations to use some means of frequently checking their transmitted frequencies with a properly calibrated instrument." Experience has shown that the use of an ordinary frequency meter (wave meter) is not a satisfactory means of fulfilling this requirement. The most satisfactory constancy of frequency has been attained by stations which use a special frequency standard adjusted to the licensed frequency of the particular station. Two satisfactory forms of standard for this purpose have been developed by the bureau. One of them is essentially a one-point wave meter, called a frequency indicator. It was briefly described in the October 1, 1925, Radio Service Bulletin, page 13, and is fully described in Bureau of Standards Letter Circular No. 180, Specifications for Radio-Frequency Indicator, Type B.

The second form of standard for use in maintenance of station frequencies is a piezo-electric quartz plate, which may be used as a resonator or as an oscillator. As an oscillator it may be used either as a master oscillator controlling the frequency of a station's output or as a frequency indicator. The last-mentioned use as a frequency indicator is particularly convenient and is described on page 2 of Bureau of Standards Letter Circular No. 186, Specifications for Portable Piezo Oscillator, Bureau of Standards Type N.

The bureau has tested the applicability of the piezo oscillator as a frequency indicator in broadcasting stations and found it to be useful and satisfactory. It is necessary that the quartz plate be ground so that one of its fundamentals or harmonics is either the exact licensed frequency of the broadcasting station or a frequency which differs from the station frequency by a small amount, such as 200 or 300 cycles. It is placed near the transmitting set, which (assuming the quartz plate is ground to the exact station frequency) is then adjusted to zero beat as determined by listening in the headphones connected in the plate circuit of the piezo oscillator. Should the station frequency vary by as small an amount as 100 cycles, it is immediately apparent by the production of a beat note of that frequency in the oscillator circuit. In case the quartz plate is ground so that its frequency differs slightly from the assigned frequency of the transmitting station—say, 300 cycles lower—the following procedure is adopted: The transmitting circuit is adjusted by passing through zero beat and then slightly increasing the frequency beyond this point until a beat note estimated to be 300 cycles is produced in the piezo oscillator circuit. The first of these two methods is probably simpler, but the proper application of either one will give a means of maintaining an extremely accurate check of the transmitting station frequency.

As compared with the use of a frequency meter or frequency indicator with visual indicating device, the piezo oscillator has two important advantages which are at once apparent. First, it is a particularly constant frequency standard, since, when properly designed, the frequency it delivers depends only on mechanical constants of the quartz plate. Second, the indicator is unaffected by amplitude or degree of modulation of the station's output. It indicates variations in frequency directly by the pitch of the beat note.

Persons interested in applying this device are advised to write to the Bureau of Standards, Washington, D. C., requesting a copy of Letter Circular No. 186, which states the conditions under which the bureau will test and adjust quartz plates.

While this application of piezo oscillators is new and has not yet had the advantage of prolonged trial under varied conditions, it seems likely that it will be very useful. If all radio transmitting stations were equipped with the device and used it properly, frequency variations and whistling interference due to beat frequencies would probably disappear.

RECRYSTALLIZATION TEMPERATURE OF COLD-ROLLED ELECTROLYTIC IRON AND OPEN-HEARTH STEEL STRIP

The stamping and drawing of iron and low-carbon steel sheet into various and sometimes rather complicated shapes plays a very important part in present-day metal manufacturing operations. Low-carbon steel or open-hearth iron sheets are usually employed commercially for this purpose. Electrolytic iron sheet has recently been advocated as a very suitable material for such operations. A preliminary annealing of the sheet prior to stamping or drawing is necessary. In addition, intermediate annealing between different stages in the drawing in order to remove the "work hardness" and enable the sheet to withstand the deformation of subsequent stages must often be resorted to. As a bearing on this problem a study has recently been carried out by the bureau of the recrystallization temperature of cold-rolled electrolytic iron and open-hearth steel strip. The mechanical properties of the cold-rolled materials after annealing at various temperature intervals up to 700° C. (1,290° F.) were determined, and the microstructural changes were studied. The results showed that the electrolytic iron sheet of the composition used was noticeably lower in its recrystallization temperature than the open-hearth steel sheet which was compared with it.

A marked recrystallization was noted in severely cold-rolled electrolytic iron sheet after it had been annealed one-half hour at 500° C., together with pronounced softening of the work-hardened sheet, whereas a similar change in the open-hearth steel sheet was not noted until after it had been annealed at 600° C. for one-half hour. This difference in the recrystallization temperatures of the two materials (100° C.) may prove to be a factor of considerable importance in promoting the use of electrolytic iron sheet.

PUBLICATIONS OF THE BUREAU OF STANDARDS ISSUED DURING JANUARY

Scientific Papers

S510. Effect of wear on the magnetic properties and tensile strength of steel wire; R. L. Sanford, W. L. Cheney, and J. M. Barry. Price, 5 cents.

Technologic Papers

T298. Radio-frequency resistance and inductance of coils used in broadcast reception; August Hund and H. B. DeGroot. Price, 10 cents.

Circulars

C24 (7th ed.). Publications of the Bureau of Standards.

C25 (supplement). Standard samples issued or in preparation.

C280. Standard time throughout the world. Price, 5 cents.

United States Government Master Specifications for—

C284. Rubber bands. Price, 5 cents.

C285. Slate-surfaced asphalt prepared roofing and shingles. Price, 5 cents.

C286. Asphalt-saturated rag felt for flashings. Price, 5 cents.

C287. Asphalt-saturated woven cotton fabric for waterproofing. Price, 5 cents.

C288. Tender hose (corrugated). Price, 5 cents.

C289. Divers' hose. Price, 5 cents.

C290. Gas hose. Price, 5 cents.

C291. Water and wash deck hose. Price, 5 cents.

C292. Water-suction hose (smooth ore). Price, 5 cents.

C293. Textile materials (methods of physical and chemical tests). Price, 5 cents.

C294. Paper towels. Price, 5 cents.

C298. Fire clay. Price, 5 cents.

Simplified Practice Recommendations, Elimination of Waste

R37. Commercial forms (invoice, inquiry, and purchase order). Price, 5 cents.

Miscellaneous Publications

M66. Second technical conference of State utility commission engineers. Price, 15 cents.

M71. Compressibilities of gases. Price, 10 cents.

OUTSIDE PUBLICATIONS

Facts and fallacies of radio wave transmission, J. H. Dellinger, Radio News, Vol. 7, p. 1139, February, 1926.

Relations between rotatory power and structure in the sugar group. XI. The related rotations of amylobiose, amylotriose, and glucose, C. S. Hudson, H. Pringsheim, and J. Leibowitz, Journal American Chemical Society, Vol. 48, p. 288, January, 1926.

Studies of salacin. Part I. Exceptional rotations of the halogeno-tetra-acetyl derivatives of salicin. A new synthesis of salicin, Alfons Kunz, Journal American Chemical Society, Vol. 48, p. 262, January, 1926.

Polarization of radiation excited by electron impact, A. Ellett, Paul D. Foote, and F. L. Mohler, Physical Review, Vol. 27, p. 31, January, 1926.

Photoionization and relative absorption probabilities of caesium vapor, F. L. Mohler, Paul D. Foote, and R. L. Chenault, Physical Review, Vol. 27, p. 37, January, 1926.

Barium sulphate as a protective material against Röntgen radiation, F. L. Hunt, American Journal of Roentgenology and Radium Therapy, Vol. 14, p. 524, December, 1925.

Effect of solvents on the absorption spectrum of a simple azo dye, Wallace R. Brode, Journal of Physical Chemistry, Vol. 30, p. 56, January, 1926.

The rapid detection of small amounts of aluminum in certain nonferrous materials, G. E. F. Lundell and H. B. Knowles, Industrial and Engineering Chemistry, January, 1926.

Analyze polishing wheel leather, R. C. Bowker, Abrasive Industry, Vol. 7, No. 1, p. 14, January, 1926.

Initial temperatures and mass effects in quenching, H. J. French and O. Z. Klopsch, Transactions American Society for Steel Treating, Vol. 9, p. 33, January, 1926.

Tensile properties of soldered joints under prolonged stress, J. R. Freeman, jr., and G. W. Quick, Metal Industry, Vol. 24, p. 7, January, 1926.

Some observations of the drying properties of clays, D. C. Lindsay and W. H. Wadleigh, Journal American Ceramic Society, Vol. VIII, No. 11, p. 677, November, 1925.

A machine for transverse tests of clay and glass laboratory specimens, A. C. Harrison, Journal American Ceramic Society, Vol. VIII, No. 11, p. 774, November, 1925.

Devitrification and tank control, Herbert Insley, The Glass Industry, Vol. 7, p. 1, January, 1926.

A National industrial laboratory, Hugh G. Boutell, The National Spectator, Vol. 1, No. 1, p. 43, January 9, 1926.

WASHINGTON : GOVERNMENT PRINTING OFFICE : 1926